White Paper Report

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Institution: Center for Research Libraries

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Grant Number: PF-50472-14

Title of Project: Implementation Grant Project

Project Director: Patrick J Lummen, M.A.

Grantee Institution: Center for Research Libraries

Report Date: 12-30-2015

Project Activities

The "Implementation Grant Project" undertaken by CRL involved the complete replacement of CRL's HVAC Building Automation System (hereafter BAS). The inability to competitively bid CRL's legacy and proprietary BAS for repair hamstrung CRL's efforts to service its control system economically. Further, old sensors were often faulty or failed completely over time, which made it impossible to rely on the information, or for the BAS to respond adequately to environmental conditions. Under the NEH-supported project, CRL successfully completed the following activities:

- replaced wiring, temperature and Relative Humidity (hereafter RH) sensors to all zones of the CRL facility.
- installed new, non-proprietary BAS software with an accessible end-user interface to replace an outdated, multi-generation control system that used proprietary software.
- implemented smarter controls for the system's chillers and air handlers, which gave CRL the ability to reduce mechanical runtime when environmental conditions allowed.

Following a competitive bidding process, CRL contracted FE Moran Mechanical to undertake the majority of project work, with additional subcontractors employed as needed for components of the implementation. Project work began in March of2014 and was completed by September 30, 2015.

Accomplishments

CRL successfully met all goals and objectives stated in the original proposal. Through the installation of new sensors and software, CRL is now able to receive consistent and accurate environmental data, which is recorded and tracked in the new system software (see Appendix A for examples of readings and inputs from the BAS software). The rewiring and repair of controls ensures that CRL may input a command into the end-user interface of the BAS and be assured that the command actually controls the mechanics of the HVAC system.

Creating a more flexible storage environment has been a priority for CRL to reduce energy waste from running equipment while meeting static storage requirements. The new BAS has allowed CRL to implement reactive temperature and humidity set-points to allow for greater temperature and humidity variance when outside conditions are severe. For example, when temperature and RH soar during the summer months in Chicago, chillers at the CRL facility would previously run at full power to meet a static 45% RH. Now, CRL's new reactive set-points change to higher temperatures and humidity levels in order to give the system a break. Similarly, when the outside temperature drops below 45 degrees, the chillers shut off, allowing the RH level to lower naturally without running the chiller unnecessarily. High limits on both temperature and RH prevent these energy efficiency changes from negatively effecting

the preservation environment by overriding the efficiency shutdown if the temperature or RH of our storage floors varies outside of CRL's accepted preservation environment range of 45-65 degrees Fahrenheit, and 30-55% RH.

To back up quantitative data provided through the BAS, CRL purchased PEM2 independent data loggers from the Image Permanence Institute for each of CRL's three storage floors. These loggers provide accurate temperature and RH data for the Center's preservation environment. Prior to this purchase CRL's most reliable environmental data came from two hygrothermographs, or handheld thermometers and sling hygrometers. Through the reports produced by the BAS and independent PEM2 loggers (continuously collected, tracked and aggregated monthly), CRL has noticed an improved and more steady preservation environment. The temperature and RH levels of all preservation storage areas have been well within the acceptable range, with only minor variations within this range due to extreme weather change. Unfortunately, as the project implementation and completion ran longer than expected due to the difficulty of tracing and removing our old HVAC control system, there has not been enough time with the new BAS and data loggers to see how the system will respond to a full spectrum of seasonal change.

From a qualitative perspective the new BAS is a significant improvement. Previously it would often be necessary to troubleshoot issues based on peripheral and dubious information from the old BAS, without the source of the alert being identifiable without a manual check. The ability to trust the new BAS data has freed Facilities staff from constantly monitoring and troubleshooting possibly phantom issues, and allowed staff to focus on optimizing the functioning of the HVAC system. The time spent manually checking the functioning of the HVAC system compared to the BAS has been greatly reduced, and Facilities staff is no longer required to "hunt down" problems, because the alert information is accurate and relevant.

Omissions or changes to project activities

None. Costs for the project were less than originally anticipated, resulting in an expenditure slightly less than awarded amounts (see final financial report for details).

Changes in project personnel

In July 2014, Don Dyer, CRL's head of facilities and designated Project Director for this grant, retired from CRL. Patrick Lummen, Head of Facilities and Collections Environment, assumed his responsibilities in July 2014, and has been the primary Project Director for the Implementation Grant Project.

Dissemination of results

CRL has publicized the improvements to its preservation environment on the CRL website, and in CRL's electronic newsletter. News concerning the project was shared with CRL member library directors and main collection contacts, and was reported at CRL's annual Council of Voting Members. The news article from the CRL website is at: https://www.crl.edu/news/crl-facilities-upgrade.

Challenges encountered

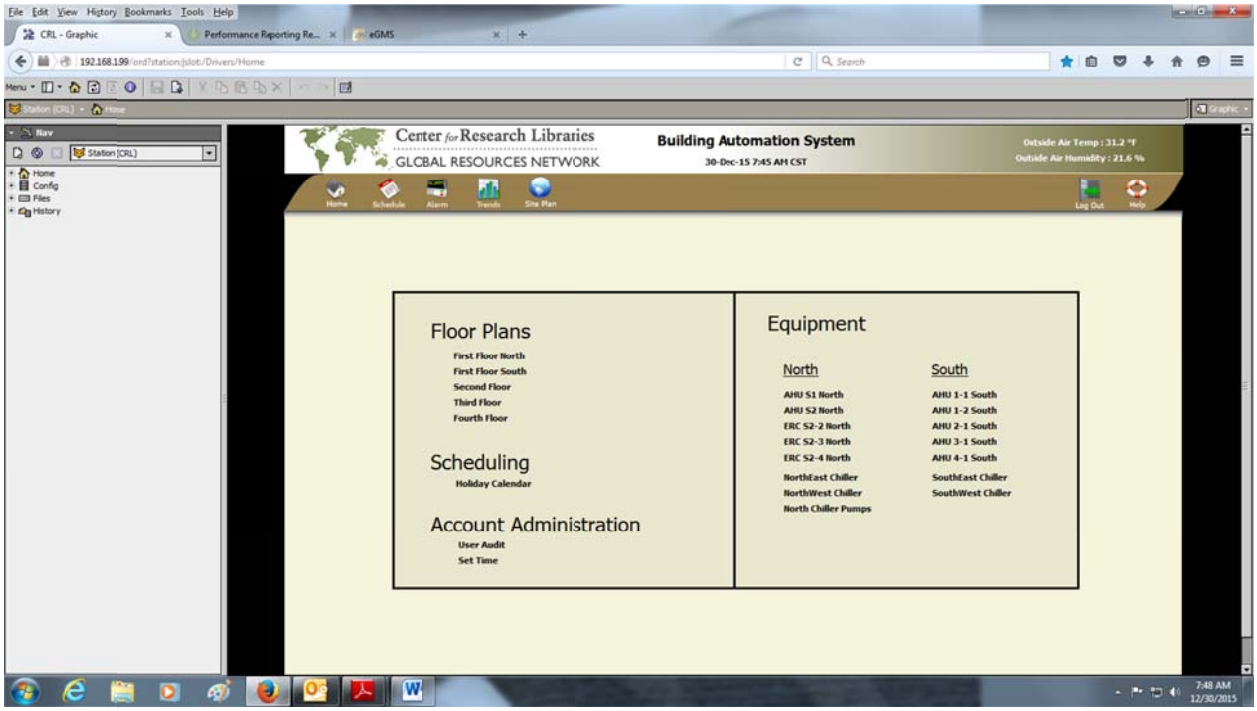
This project has been challenging on several levels, especially for a project manager only recently familiar with CRL's facilities. One difficulty that was encountered pertained to keeping the scope of the project in view while dealing with several subcontractors. Electricians contracted to run the new wiring and sensors often believed the scope of their work to be less than what was required. This necessitated continual oversight and communication between CRL staff, FE Moran, and the subcontractors. The work was complicated further because there was no definitive set of schematics for CRL's old BAS. Therefore some controls were inevitably missed and return work was required.

Additionally, the mere size and complexity of CRL's HVAC system presented a challenge. The amount of work that was required by both CRL staff and FE Moran in order to optimize the functioning of the new system after the completion of the majority of the work was unanticipated. This required strong communication between CRL staff and the contractors performing the work. Fortunately, as the Project Director had considerable previous experience with collections care at CRL, he was able to apply his knowledge of CRL's preservation needs to the technical specifications required to optimize the HVAC operations. It was also helpful that the principal contractor, FE Moran, has considerable experience working with clients who require specialized environments. This experience ensured that they were comfortable working outside of the traditional comfort control range.

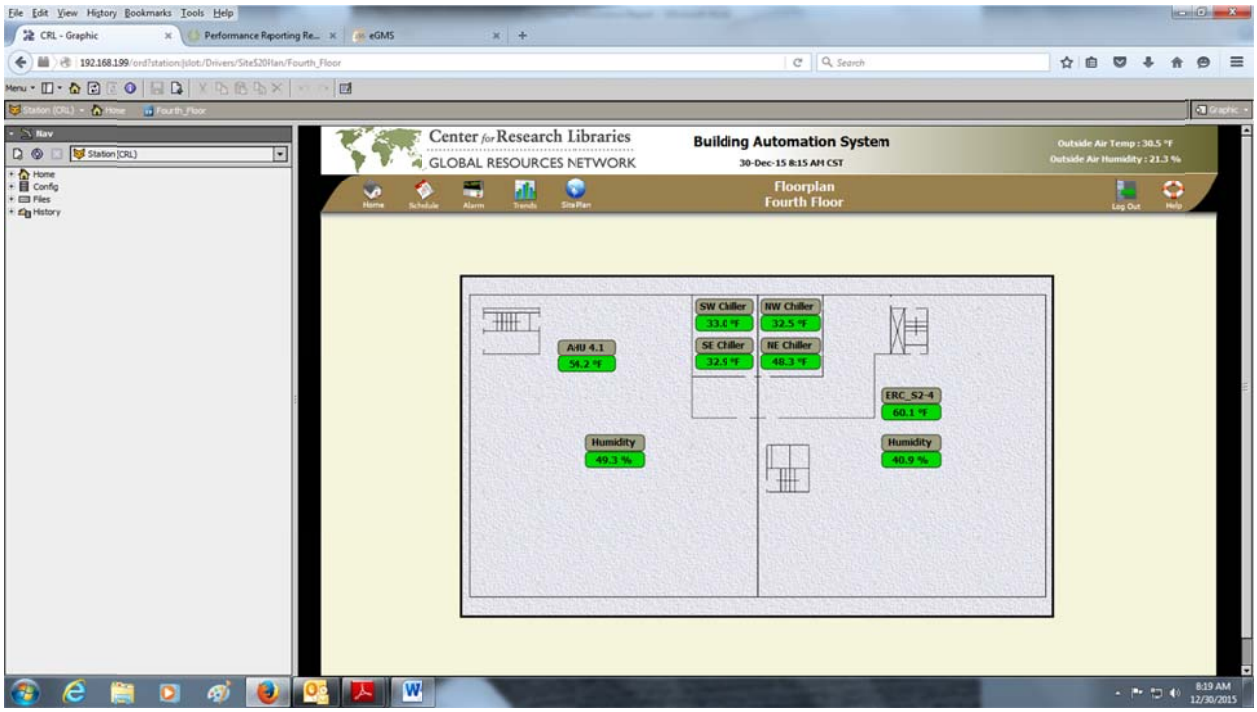
Continuation of the Project

CRL is planning to upgrade its humidification system for dry winter months as a means of fully optimizing its preservation efforts. The continued commitment of CRL to the preservation of its physical collection is central to completing its mission on behalf of its members. The long term preservation of CRL resources is a mission critical activity at the Center, and one the effects of which cannot be measured.

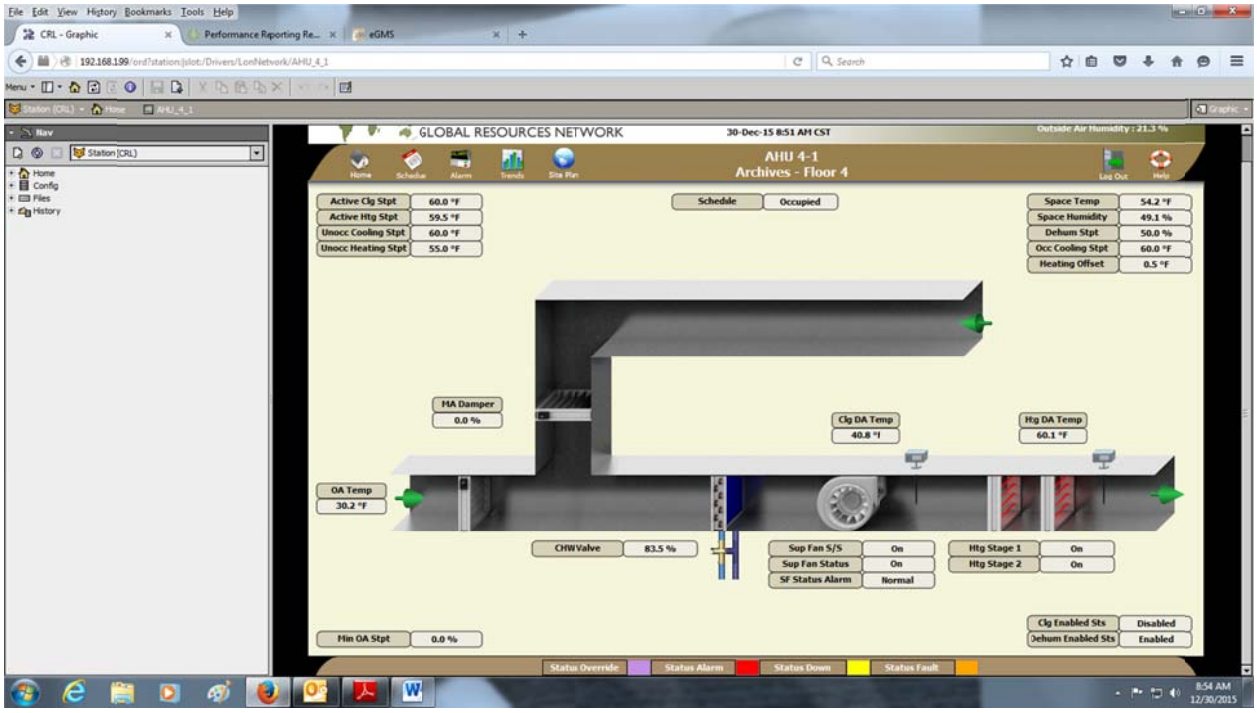
Appendix A: BAS end user software



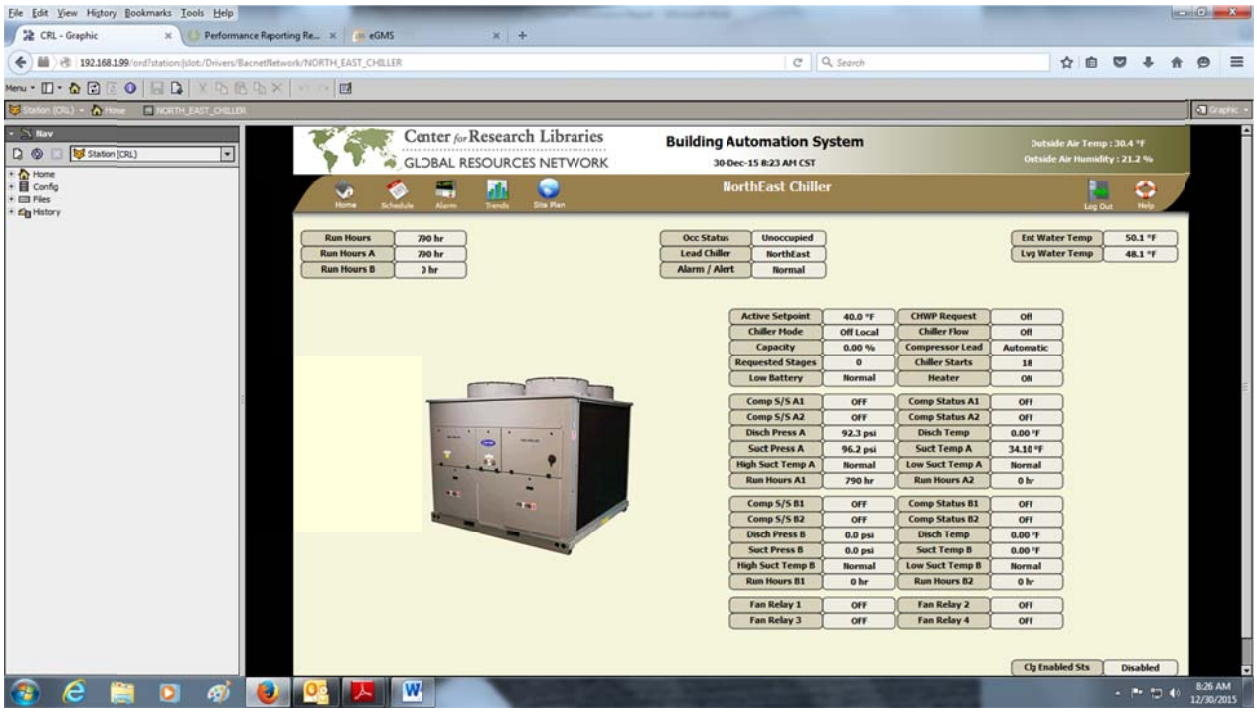
The home page for CRL's end user interface on the new BAS.



The floor plan for CRL's 4th floor storage area. Links from here go to the following images.



Control interface for CRL's 4th floor south air handler.



BAS interface for the north east chiller unit.

Appendix B: BAS hardware

New pneumatics and controls for the S-2 Air Handler, which serves CRL's north side storage floors. The new box was built inside the old Robert Shaw box.

New pneumatics and controls for the 4-1 air handler serving our south side 4th floor storage area.

New Honeywell temperature and RH sensor on CRL's south side storage floor.

Appendix C: Example report from PEM2 data loggers

*See attached pdf.

2nd FLR North

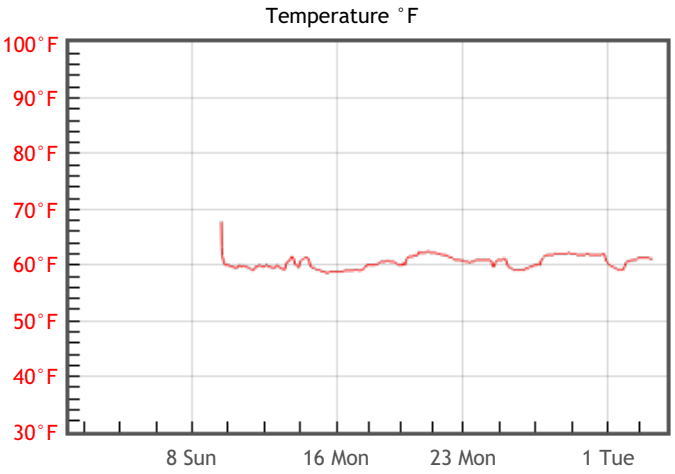
Center for Research Libraries

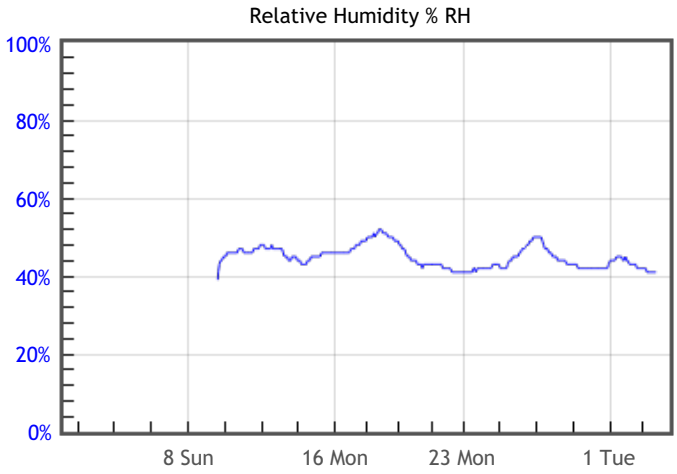
2015-11-09 to 2015-12-03
25 days

Preservation Environment Evaluation

Type of Decay	Risks & Metrics	Evaluation & General Comments
Natural Aging Chemical decay of organic materials	GOOD TWPI = 83	Slow rate of chemical decay in organic materials such as paper, leather, textiles, plastics and dyes
Mechanical Damage Physical damage to hygroscopic materials	GOOD % DC = 0.37 % EMC min = 7.6 % EMC max = 8.9	Minimal risk of physical damage to most hygroscopic materials such as paintings, rare books and furniture.
Mold Risk Mold growth in area or on collection objects	GOOD MRF = 0	Minimal risk of mold growth.
Metal Corrosion Corrosion of metal components or objects	OK % EMC max = 8.9	Generally OK, but archeological or salt-encrusted metals may corrode due to extended periods of moderately high levels of humidity.

Graphs





Statistics

Temperature		Relative Humidity		Dew Point	
T°F Mean	60.5	**%RH Mean**	45	**DP°F Mean**	38.9
T°F Median	60.6	**%RH Median**	45	**DP°F Median**	38.6
T°F Stdev	1.1	**%RH Stdev**	3	**DP°F Stdev**	1.3
T°F Min	58.6	**%RH Min**	39	**DP°F Min**	36.6
T°F Max	67.8	**%RH Max**	52	**DP°F Max**	42.9

2nd FLR South

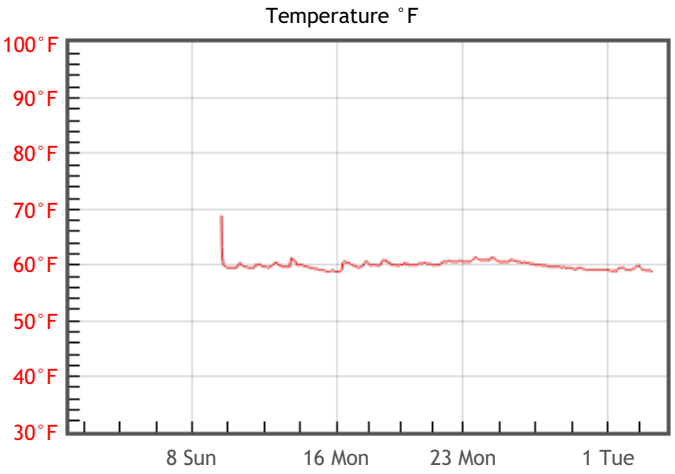
Center for Research Libraries

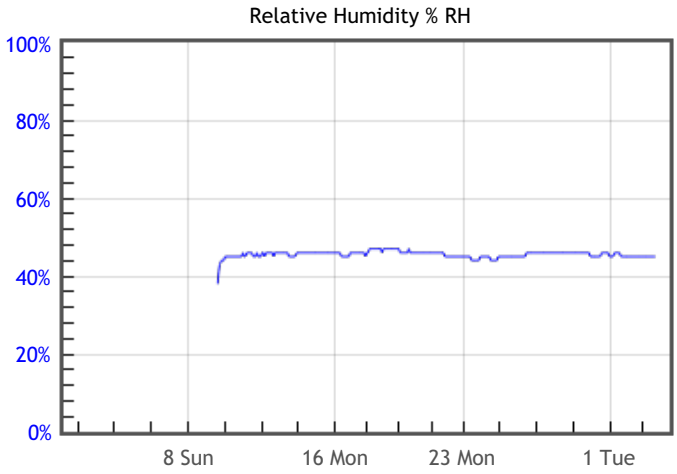
2015-11-09 to 2015-12-03
25 days

Preservation Environment Evaluation

Type of Decay	Risks & Metrics	Evaluation & General Comments
Natural Aging Chemical decay of organic materials	GOOD TWPI = 86	Slow rate of chemical decay in organic materials such as paper, leather, textiles, plastics and dyes
Mechanical Damage Physical damage to hygroscopic materials	GOOD % DC = 0.38 % EMC min = 7.4 % EMC max = 8.7	Minimal risk of physical damage to most hygroscopic materials such as paintings, rare books and furniture.
Mold Risk Mold growth in area or on collection objects	GOOD MRF = 0	Minimal risk of mold growth.
Metal Corrosion Corrosion of metal components or objects	OK % EMC max = 8.7	Generally OK, but archeological or salt-encrusted metals may corrode due to extended periods of moderately high levels of humidity.

Graphs





Statistics

Temperature		Relative Humidity		Dew Point	
T°F Mean	59.9	**%RH Mean**	46	**DP°F Mean**	38.9
T°F Median	59.9	**%RH Median**	46	**DP°F Median**	39
T°F Stdev	0.7	**%RH Stdev**	1	**DP°F Stdev**	0.6
T°F Min	58.8	**%RH Min**	38	**DP°F Min**	37.4
T°F Max	68.9	**%RH Max**	48	**DP°F Max**	42.2

3rd FLR North

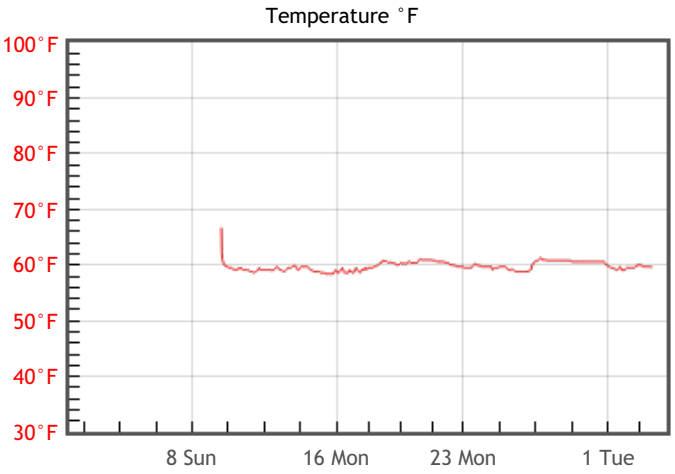
Center for Research Libraries

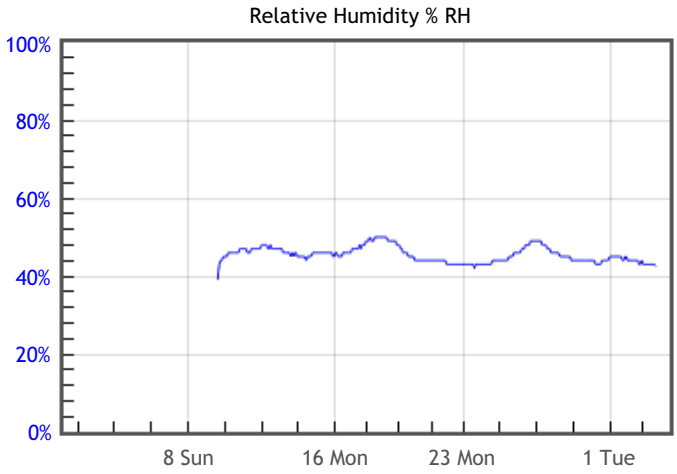
2015-11-09 to 2015-12-03
25 days

Preservation Environment Evaluation

Type of Decay	Risks & Metrics	Evaluation & General Comments
Natural Aging Chemical decay of organic materials	GOOD TWPI = 87	Slow rate of chemical decay in organic materials such as paper, leather, textiles, plastics and dyes
Mechanical Damage Physical damage to hygroscopic materials	GOOD % DC = 0.37 % EMC min = 7.6 % EMC max = 8.9	Minimal risk of physical damage to most hygroscopic materials such as paintings, rare books and furniture.
Mold Risk Mold growth in area or on collection objects	GOOD MRF = 0	Minimal risk of mold growth.
Metal Corrosion Corrosion of metal components or objects	OK % EMC max = 8.9	Generally OK, but archeological or salt-encrusted metals may corrode due to extended periods of moderately high levels of humidity.

Graphs





Statistics

Temperature		Relative Humidity		Dew Point	
T°F Mean	59.8	**%RH Mean**	45	**DP°F Mean**	38.6
T°F Median	59.7	**%RH Median**	45	**DP°F Median**	38.6
T°F Stdev	0.8	**%RH Stdev**	2	**DP°F Stdev**	1.2
T°F Min	58.4	**%RH Min**	39	**DP°F Min**	36.4
T°F Max	66.7	**%RH Max**	51	**DP°F Max**	42.2

3rd FLR South

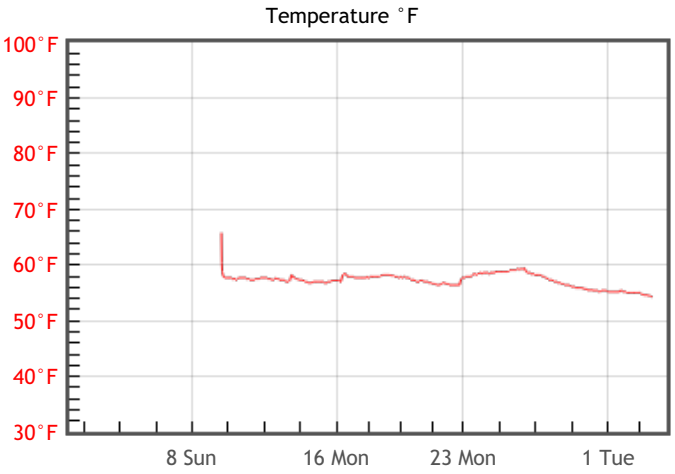
Center for Research Libraries

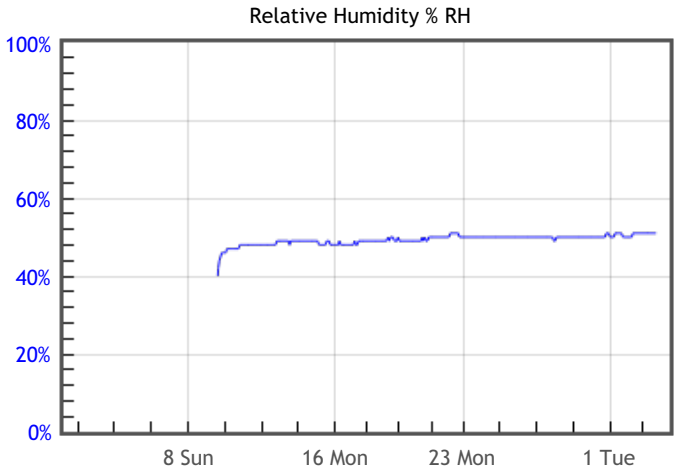
2015-11-09 to 2015-12-03
25 days

Preservation Environment Evaluation

Type of Decay	Risks & Metrics	Evaluation & General Comments
Natural Aging Chemical decay of organic materials	GOOD TWPI = 97	Slow rate of chemical decay in organic materials such as paper, leather, textiles, plastics and dyes
Mechanical Damage Physical damage to hygroscopic materials	GOOD % DC = 0.43 % EMC min = 7.7 % EMC max = 9.3	Minimal risk of physical damage to most hygroscopic materials such as paintings, rare books and furniture.
Mold Risk Mold growth in area or on collection objects	GOOD MRF = 0	Minimal risk of mold growth.
Metal Corrosion Corrosion of metal components or objects	OK % EMC max = 9.3	Generally OK, but archeological or salt-encrusted metals may corrode due to extended periods of moderately high levels of humidity.

Graphs





Statistics

Temperature		Relative Humidity		Dew Point	
T°F Mean	57.2	**%RH Mean**	49	**DP°F Mean**	38.4
T°F Median	57.3	**%RH Median**	50	**DP°F Median**	38.2
T°F Stdev	1.2	**%RH Stdev**	1	**DP°F Stdev**	1
T°F Min	54.5	**%RH Min**	40	**DP°F Min**	36.1
T°F Max	65.8	**%RH Max**	51	**DP°F Max**	40.8

4th FLR North

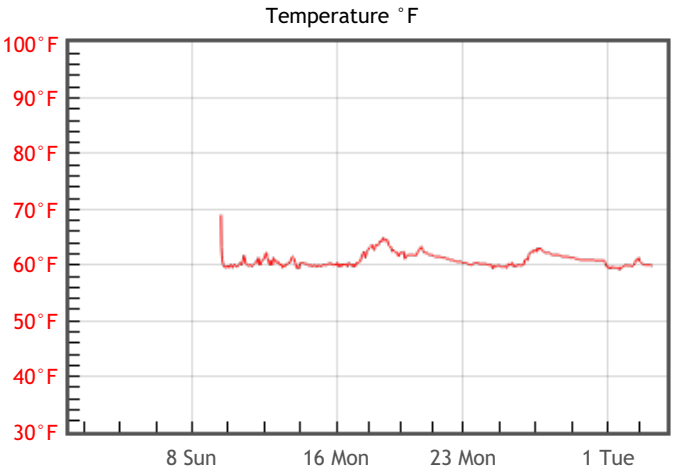
Center for Research Libraries

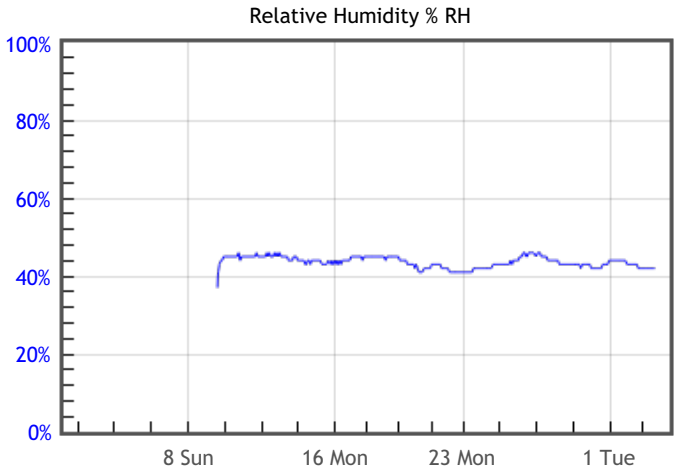
2015-11-09 to 2015-12-03
25 days

Preservation Environment Evaluation

Type of Decay	Risks & Metrics	Evaluation & General Comments
Natural Aging Chemical decay of organic materials	GOOD TWPI = 82	Slow rate of chemical decay in organic materials such as paper, leather, textiles, plastics and dyes
Mechanical Damage Physical damage to hygroscopic materials	GOOD % DC = 0.37 % EMC min = 7.2 % EMC max = 8.6	Minimal risk of physical damage to most hygroscopic materials such as paintings, rare books and furniture.
Mold Risk Mold growth in area or on collection objects	GOOD MRF = 0	Minimal risk of mold growth.
Metal Corrosion Corrosion of metal components or objects	OK % EMC max = 8.6	Generally OK, but archeological or salt-encrusted metals may corrode due to extended periods of moderately high levels of humidity.

Graphs





Statistics

Temperature		Relative Humidity		Dew Point	
T°F Mean	60.9	**%RH Mean**	44	**DP°F Mean**	38.6
T°F Median	60.6	**%RH Median**	44	**DP°F Median**	38.3
T°F Stdev	1.2	**%RH Stdev**	1	**DP°F Stdev**	1.4
T°F Min	59.1	**%RH Min**	37	**DP°F Min**	36.2
T°F Max	69	**%RH Max**	46	**DP°F Max**	42.9

4th FLR South

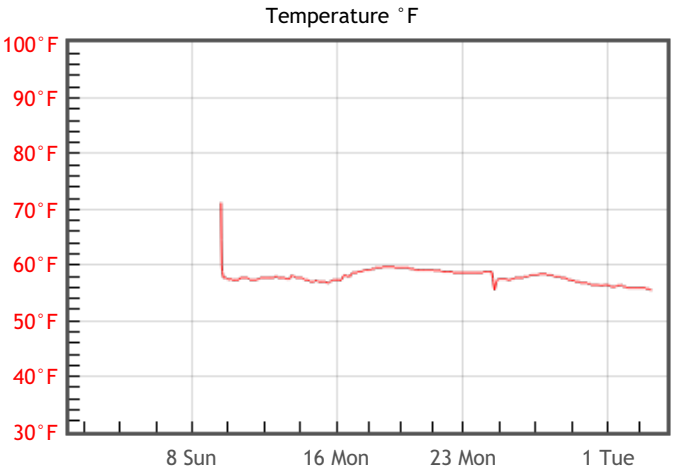
Center for Research Libraries

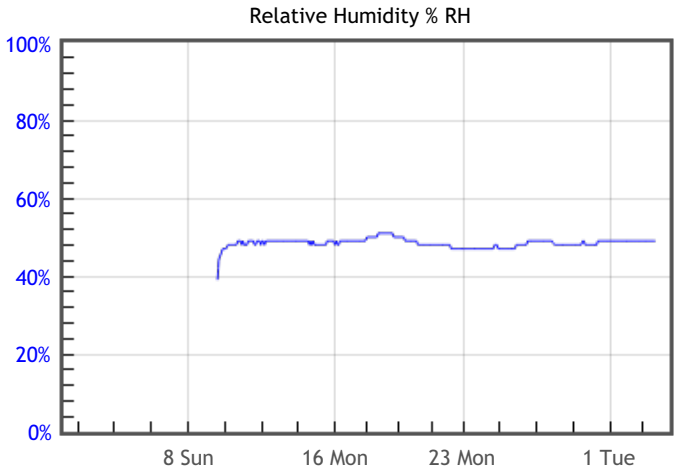
2015-11-09 to 2015-12-03
25 days

Preservation Environment Evaluation

Type of Decay	Risks & Metrics	Evaluation & General Comments
Natural Aging Chemical decay of organic materials	GOOD TWPI = 93	Slow rate of chemical decay in organic materials such as paper, leather, textiles, plastics and dyes
Mechanical Damage Physical damage to hygroscopic materials	GOOD % DC = 0.48 % EMC min = 7.5 % EMC max = 9.3	Minimal risk of physical damage to most hygroscopic materials such as paintings, rare books and furniture.
Mold Risk Mold growth in area or on collection objects	GOOD MRF = 0	Minimal risk of mold growth.
Metal Corrosion Corrosion of metal components or objects	OK % EMC max = 9.3	Generally OK, but archeological or salt-encrusted metals may corrode due to extended periods of moderately high levels of humidity.

Graphs





Statistics

Temperature		Relative Humidity		Dew Point	
T°F Mean	57.8	**%RH Mean**	48	**DP°F Mean**	38.5
T°F Median	57.7	**%RH Median**	49	**DP°F Median**	38.4
T°F Stdev	1.1	**%RH Stdev**	1	**DP°F Stdev**	1.2
T°F Min	55.5	**%RH Min**	39	**DP°F Min**	36.3
T°F Max	71.2	**%RH Max**	51	**DP°F Max**	45